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Resources of the Tropics: II–*South America*

Tropical South America is one of the world's superlative sources of the raw materials that enter into international trade, but so far only a minute portion of its resources have become available either to the South Americans themselves or to the world. The continent has been settled for more than four hundred years, yet there are still vast areas that are practically uninhabited. Part of the difficulty lies in the terrain and climate, and part is due to a deficiency of some of the basic economic and social stimuli needed for modern exploitation.

The magnitude of the Andes creates extraordinary problems for transportation (see maps): railroads must climb to nearly 16,000 feet, higher than most peaks in the Swiss Alps; roads must be constructed to much greater heights. The Pacific coast in Colombia is one of the rainiest in the world; in Peru and northern Chile it is one of the driest. The Andean barrier leaves the great central lowlands virtually inaccessible from the west, and the humid tropical forest of the Amazon, which stretches 1,900 miles eastward to the Atlantic, is readily penetrable only by water. Lowland road building is particularly difficult, since deep weathering of the soils has left scarcely any durable materials. The rich uplands of eastern Brazil are flanked on the Atlantic front by steep escarpments, and approach by way of Amazonian waterways is interrupted by unnavigable rapids. The Guiana hinterland of the northeast is even less accessible.

The airplane is remarkably effective for the rapid movement of man, mails, and small shipments of agricultural and animal products from one remote place to another or for the opening up of small mining centers, but aviation has yet to reach the stage where large developments can be economically serviced by it alone. However, with the aid of the aerial camera, the science of photogrammetry, and photo-interpretation, detailed and accurate maps can be prepared and the physical problems of resource development in virgin land much more readily understood than was possible before the air age.

Though four of the South American nations — Bolivia, Chile, Peru, and Venezuela — would never have attained their present world significance without minerals, the remainder are known primarily for their crops or animal products. Coffee from Brazil and Colombia, cacao from Brazil and Ecuador, bananas, cotton, and a host of other tropical commodities (including tonka bean, vanilla, cinchona, caster-oil bean, carnauba, and curare) are immediately associated with tropical America.

Its mineral reserves are among the largest in the world. The iron-ore deposits of southeastern Brazil, the greatest of which are near Itabira, are estimated

to contain some 13 billion tons of high-grade ore, a quarter of the known world reserve. Their exploitation has been, and still is, on a relatively small scale, except in the vicinity of a large modern steel plant at Volta Redonda, northwest of Rio de Janeiro. The world's largest known copper ore body is located at Chuquicamata, Chile. The Chilean desert remains the principal source of natural nitrates. Peru, a large copper producer, leads in vanadium and bismuth. Bolivia stands second in world tin production, and Venezuela leads in petroleum exports. Perhaps the greatest manganese reserve in the world is in southwestern Brazil.

But with all this mineral wealth, South America (like Africa) suffers from a poverty of good coal. Lignitic and semibituminous deposits near Lota, Chile, are the best. Brazil, with so much iron, has only a few coal deposits, of such high ash content that special processing is required. Small fields exist in nearly all the countries, but none of them can supply national needs. Petroleum now supplants coal for many purposes, and natural gas is coming into its own in Argentina and Venezuela. Water resources are large, but they have been little exploited. Brazil, with an estimated water-power potential of 19,500,000 horsepower, utilizes a bare 3 per cent of it. In an industrial era such as ours, when coal is the main source of energy, this deficiency is a serious handicap.

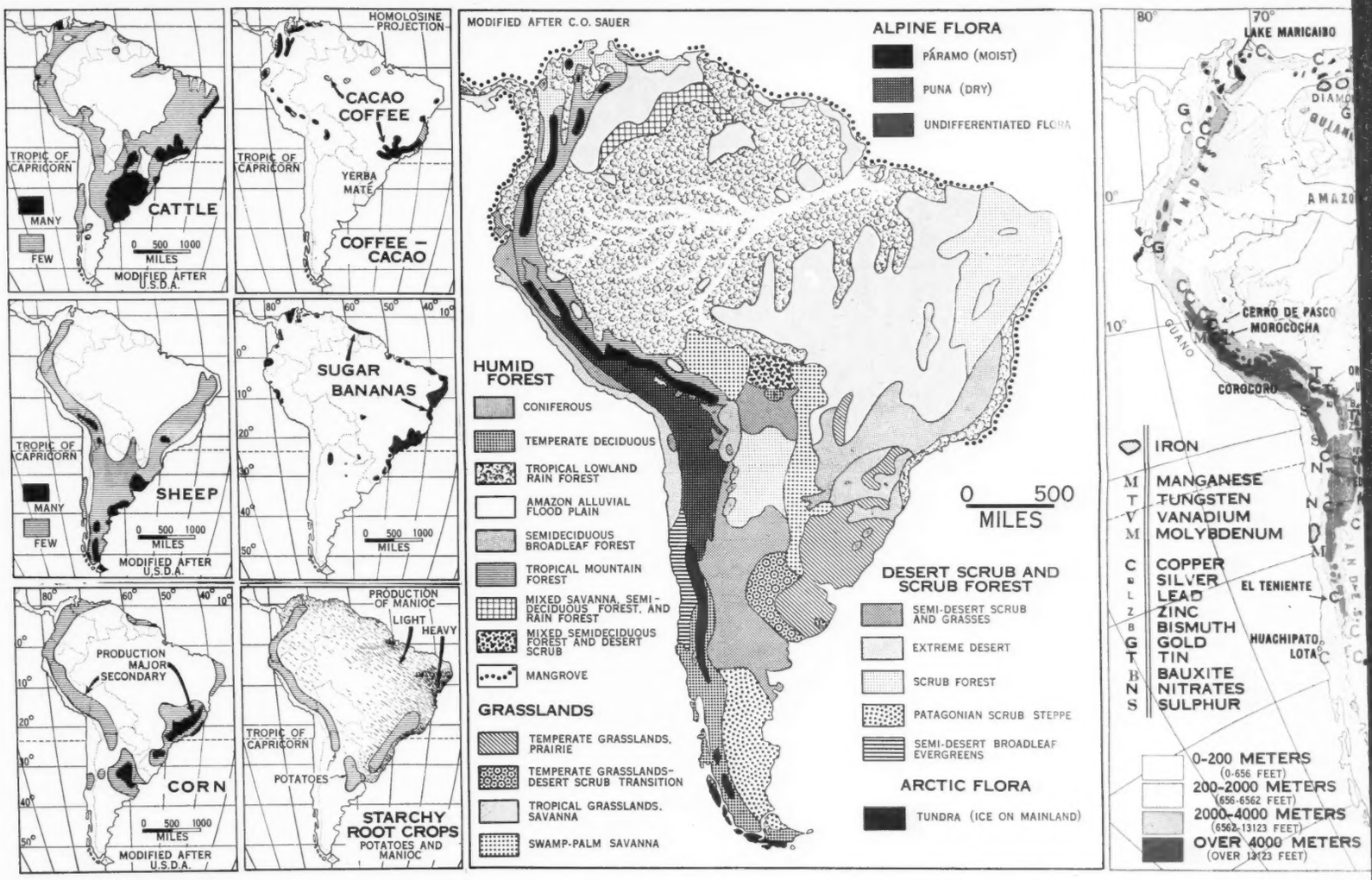
Any assessment of resource development must take into consideration many variables, such as future means of transportation, technological advances, national attitudes, social composition and customs, and terrain, climate, and vegetation. Man is forever trying to rebuild the pattern of the landscape to meet his needs. When a venture no longer brings a worthwhile return by ordinary procedures, be it money or food, he is apt to drop it. There are literally hundreds of abandoned mines in the highly mineralized Andes, which, with proper conditions and incentive, might be reopened. Improved transportation facilities might well justify the extraction of a lower grade of ore, or the exploitation of known deposits hitherto untouched because of their inaccessibility.

Abandoned mining areas may be revitalized by the use of new processes. The nitrate desert of northern Chile is a striking example. In a region of many "ghost towns," tombstones marking once-thriving nitrate plants, two establishments, at Pedro de Valdivia and nearby María Elena, have been put into operation in recent years by using the new Guggenheim process. By this method profitable mining of 7 to 8 per cent ore with 85 per cent recovery is possible. About 1,350,000 tons of nitrates were produced by these two plants in 1952.

Temporarily unusable reserves may at times be set aside for future use. In the 1920's, at the Chuquicamata, Chile, copper deposit, stripping of the upper oxidized layer was relatively simple. As the stripping proceeded, mixed oxide and sulphide ore began to appear; still deeper was the main deposit of pure sulphide. The leaching process applicable to the extraction of copper from the oxides would not permit its recovery from the sulphides. The "unusable" sulphide tailings were stored in huge dumps until in July, 1952, a new sulphide treatment plant began processing them.

North American and European demands also play an important part in South American production. Two examples, tin and sulphur, illustrate this. The tremendous boom in tin mining during and immediately after the last World War has been followed by greatly decreased production (in 1952 it reached a four-year low); to a large extent this is a reflection of foreign needs. On the other hand, the present acute world shortage of sulphur has given the century-old sulphur-mining industry of Chile a sudden stimulus. Roads are being constructed at altitudes above 17,000 feet; new processing plants are being built. The production estimate for 1953 is 50,000 long tons, only a small fraction of the six million tons produced annually in the United States; but, as William Rudolph puts it, "Chile is a youth in the sulphur industry, whereas the United States and Italy have been fast using up their better reserves." Chilean sulphur reserves have been estimated at 400 million metric tons. Ecuador, one of the least important mineral-producing countries of South America, began sulphur mining at the rate of 1,000 tons per month in 1952, and will probably reach the 7,000-ton mark in 1953.

Agriculturally, there is more preoccupation with the adequate feeding of the population than with developing resources for export. At the moment, large amounts are being spent to import food, much of which might be produced at home if proper agricultural techniques were more widely encouraged. Tropical soils in South America have very small crop capacities in comparison with those of higher latitudes. Many of the areas reasonably accessible to the oceans have been farmed or grazed with little regard for this fact. A land-tenure system inherited from the

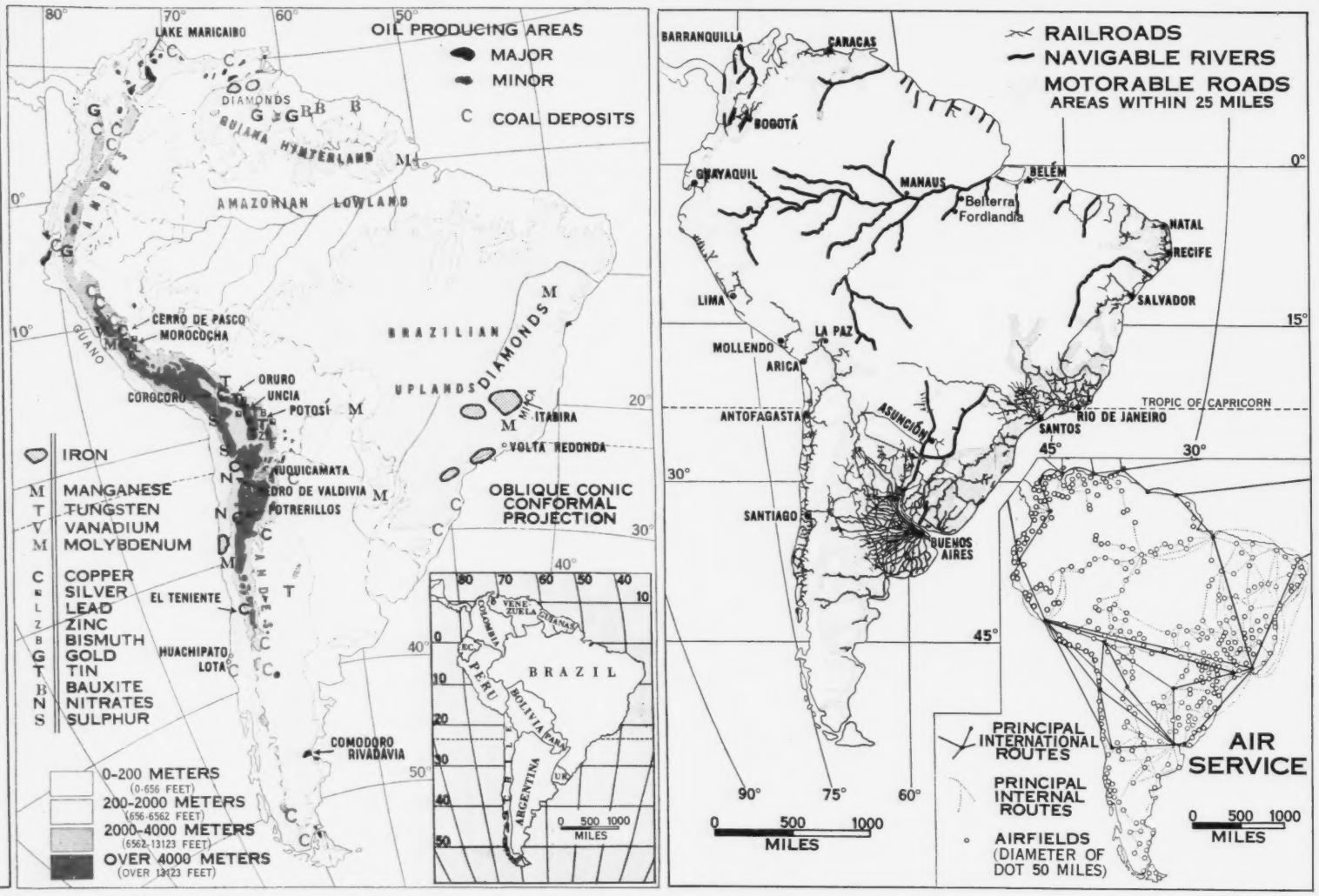


Maps drawn by Vincent Kotschar

early Spanish and Portuguese *conquistadores* often provides a setting of huge landholdings, absentee landlords, and tenant farmers. A common sequence of events (outside the humid tropical forest, or *selva*, of Amazonia) is to cut the forest, plant crops, and then, after one to three years, abandon the land because of diminishing returns. Eventually, second-growth scrub and grasses appear, which, at their best, provide poor grazing; as much as 25 acres of this impoverished land may be needed to pasture one head of cattle. Immense areas are natural or, in part, man-made grasslands, or *savannas,* whose soils are notably deficient in plant food. The *llanos* of Colombia and Venezuela and the great grasslands of interior Brazil appear usable primarily only for grazing. In the populated Andean uplands also, soils are thin and poor, and subsistence farming is the rule; and in the more arid lower regions goats are the chief resource.

Occasionally, a particularly valuable and relatively long-lasting soil is encountered. The red soils of the large coffee plantations in Brazil have been producing abundantly for 50 or 60 years. Brazil is still the foremost coffee exporter, supplying 58 per cent of the world's total; but signs of soil exhaustion are not lacking, and the outlook for the future is not so happy. The red forest soil suitable for high coffee growing is being rapidly consumed. Coffee is now being planted on poorer soils, where the bushes will produce for no more than five to eight years. In spite of having planted 600 million bushes in the last 20 years, the country has lost a billion bushes, and will lose another billion by 1970.

One of the major evils of tropical American farming has been the desire on the part of the landlords for quick profits. For this cheap labor was necessary and, as in most other parts of the tropics, cheap labor



is anything but efficient in its use of the soil. However, much land previously abandoned to scrub and grazing is still capable of being brought back into cultivation if properly handled. This does not mean that the mechanized techniques common in North America and Europe should be implanted in the American tropical scene; in fact, where such techniques have been adopted they have generally failed. Rather does it mean that new procedures specially tailored for the tropics must be devised. Realizing this, several South American countries have established agricultural and animal husbandry experiment stations. Recently, the American International Association for Economic and Social Development has been working with the governments of Brazil and Venezuela to improve rural productive facilities, education, and health by means of technical assistance programs; one of the major problems is how to impart this new knowledge to the many as well as to the few.

The sparsely populated Amazonian selva presents perhaps one of the toughest problems of all. Opinions about its potentialities differ widely. Some people continue to think that the luxuriance of the forest means richness of the soil, and that, given better living conditions and modern transportation, the trees can be cut down and valuable crops grown.

The soils of the Amazon Basin are high in silica; only those subject to annual flooding are replenished with silt. A glance at the vegetation map reveals that the flood areas (perhaps exaggerated) are infinitesimal in comparison with the total selva. Soil scientists know that in sandy soils in humid equatorial regions the plant tissues contain more mineral reserves than the soil itself. There appears to be a balanced cycle in which leaves and trees are constantly falling, being

attacked by bacteria and termites, rotting, and returning to the trees as plant nutrients. If the forest is destroyed, the cycle is broken, and the soil is leached of its mineral content beyond the depths to which young roots can reach. From such soil, two or three crops at most can be extracted. The re-establishment of forest is reported to be all but impossible. Improperly handled, the valuable Amazon forest reserve will be as nonrenewable a resource as the tin extracted from a Bolivian mine and shipped to Britain.

Felisberto de Camargo, director of the Northern Agricultural Institute at Belém, made a scientific study of a Brazilian development scheme carried out east of that city, where the thick forest was cut and burned to plant manioc and cereals. After two or three crops the soil was exhausted. Sr. de Camargo came to the conclusion that only in the shunned floodlands can intensive agriculture be attempted. As he put it, "in this piece of Brazilian land, imprudence, ignorance of the nature and composition of the soil, and lack of any systematic planning have led governmental and private initiative to commit grave errors both in the exploitation of the land and in the question of social organization." Nevertheless, through the sufferings of this area, Brazil has been taught a lesson with respect to future development of its Amazonian resources.

Henry Ford's rubber plantations at Fordlandia and Belterra were established under the guidance of competent Brazilian and American technologists. One of the problems connected with commercial tapping of native rubber trees is the distance between trees; another is labor shortage. The plantations appeared to solve these difficulties; but the closely spaced trees eventually proved to be a target for an unforeseen air-borne fungus disease. Since the resale of the two holdings to the Brazilian government, Southeast Asian stock has been grafted on Brazilian seedlings, with apparent success. Rubber achievements in Asia and at the Firestone plantation in Liberia may well be duplicated eventually in Amazonia.

Robert L. Pendleton has emphasized the unique qualities of lowland rice as a food plant—its ability to persist even on the poorest soils and at the same time feed a large population. If man is to move into Amazonia in increasing numbers, lowland rice may be a principal means of solving his food problems.

There is a growing awareness of the need for more and better subsistence agriculture and more and better technology if the enormous resources of tropical South America are to be used intelligently; ultimately, however their development by internal and foreign interests rests largely on the policies adopted by the national governments.

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